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ABSTRACT

The study described in this report examined the ways in which teachers prepare to teach using microcomputers. The participants in the study were four teachers who used computers in instruction, and who had been identified as outstanding by an educational foundation. They represented elementary special education, high school gifted education, junior high technology education, and high school English. These teachers were observed in their classrooms and interviewed, and their planning books, notes, and handouts were reviewed, in order to analyze the processes they engaged in when designing instruction for class lessons, units, and courses. The results of the analysis revealed that these processes, whether or not they involved computers and computer-assisted instruction, were previously established, highly individualized, largely unspoken, and, for the most part, shared among all teachers. It is concluded that: (1) the teachers' innovative use of computers in instruction resulted from the previously established processes and not from any value or worth intrinsic to the computer; and (2) future inservice teacher education should help teachers develop their own teaching methods and processes of design and allow them to incorporate the use of technology in the realization of their educational goals. (35 references) (DB)

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Teaching with Technology:

"It's Just a Tool."

by Elizabeth Uzdavinis Carlson

University of Michigan

Paper presented at the Annual Conference
of the American Educational Research Association
(Chicago, Illinois, April 3-7, 1991)

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TEACHING WITH TECHNOLOGY: "IT'S JUST A TOOL."

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ABSTRACT

Teachers are under pressure to use computer-related technology in instruction, yet they have few models of how these devices can become a part of their instructional repertoires. Studies thus far have focused on the effectiveness of computers as instructional devices, or on the characteristics of teachers who use computers. Little is known about *how* teachers use computers in instruction, therefore, this study focused on the processes teachers use to prepare to teach with computers. By explicating the design worlds of these teachers, this study has revealed features of the processes by which teachers create instruction in which they use forms of technology.

PROBLEM

The failure of schools to use technology has been added to the list of schools' shortcomings. This complaint arises not only from noneducational sectors of society, but from educators as well. For example, a resolution adopted by the Association for Supervision and Curriculum Development (1989), for example, notes that schools use technology less than other sectors of society, yet the need for the use of technology grows more critical (ASCD, 1989). Critics of the schools point out that computers are accepted tools in the culture as a whole, and although computers offer a wide variety of uses for teachers and learners, schools continue to lag behind other segments of society in the use of these machines. In Papert's (1988) view, society is becoming a "computer culture" in which schools will be left behind because educators failed to reconceptualize the uses of the computer and train teachers to lead the movement for changes in schools; others (Bork, 1987; Bosco, 1987; Linn, 1986) have similar concerns.

Critics cite three conditions related to the failure of computers to take hold in the schools: not enough hardware, the lack of good software, and inadequate training for teachers. Of these, states a report to the U.S. Congress, "teacher training is one factor most frequently mentioned ... as the most important ingredient effecting implementation of new technology" (OTA, 1988, p. 17). Given present trends, it is likely that schools will continue to increase the amount of technology they have (Becker, 1988), thereby increasing access to computers for teachers and students. Providing more equipment and software is a necessary step, but it is not sufficient to cause significant changes in teachers' use of computers. Regardless of any increase in the number of computers in schools, teachers' abilities to use them to further their instructional goals will determine their effectiveness as tools. As has been shown (Kearsley, 1984; Mitterer, 1988), the most important factor in how much a technology can help is the way it is used. The effective use of computers and software, as with all other educational materials and media, depends on the skills of the teachers who use them in creating and providing instruction. The integration of technology into the curricula will rely on teachers' abilities to use computers and other technology in ways that address teachers' goals. Teachers need training in which there is less emphasis on technical skills, and more emphasis on the process of determining the appropriate use of computers in instruction. To educate teachers more effectively, teacher educators need to know more about how teachers design instruction in which technology is used, what assumptions they hold about technology, how they approach the use of computers and other media, and how teachers prepare for instruction in which computers play a part.

Purpose of the study

The purpose of this study, then, was to discover how teachers prepare for instruction in which computers are used. I addressed these questions:

- What are the critical elements in the processes teachers employ to prepare instruction in which computers and other technology are used?
- What motivates or prompts computer use in teachers' preparation for instruction?

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- What questions do teachers ask while preparing for instruction? What resources, procedures, and strategies do they use?
- What understandings and beliefs do teachers have about the use of computers in instruction, and how are these ideas incorporated into the design of lessons?

My intent was to explore the range of variation in the processes teachers use to prepare instruction, and to disclose the significant features of these processes as understood and experienced by teachers. I focused on identifying the means by which teachers, during the design of instruction, frame the question of when and how to use computers with their students. I attempted to create a picture of what is involved when teachers prepare instruction, what teachers know and do while preparing for instruction.

METHOD

The participants for the study were purposefully selected as successful, experienced teachers who use computers in instruction; they are the key actors in this situation (Patton, 1987). Several programs exist that identify outstanding leadership and achievement by educators. One such program, particularly relevant to the goals of this study, is sponsored by a foundation which each year conducts a nationwide search for five public school educators who have demonstrated innovative use of technology in teaching and learning. Experts identify outstanding teachers using the following selection criteria: uses technology in teaching; demonstrates extraordinary pedagogical skills; recognized by peers as leaders; and helps other professionals in using technology in education. The participants in this study are the five teachers selected by the foundation during a past year.

Although all five teachers expressed interest in participating in the study, only four of the five teachers were able to participate in the full study including interviews and classroom observations. Because of restrictions on visitors at one teacher's school, I was not able to observe this teacher in school. Therefore, I did not use that case in this study. The four teachers whose cases are used in this study reflect a wide range of situations. Three teach in small towns: one rural, the other two close to metropolitan areas. The fourth teaches in a suburb of a large city. They are from several regions of the country. The teachers, two males and two females, have taught from nine to 32 years. They come from several areas of teaching: elementary special education, high school gifted education, junior high technology education, and high school English. One has a masters degree and another has a doctorate.

Procedures

I designed the information collection portion of the study to occur during a week-long visit to each of the teachers. These visits allowed me to see the teacher in his or her local context, both at school and at home. During these visits, I took the role of an observer and analyst. I observed the teachers in their classrooms during the school day, and interviewed them before and after the school day and on the weekend. Discussions continued in the evenings when we reflected on the events that occurred during the day, and their thoughts about these events. We used documents such as plan books and notes, handouts, and course descriptions in the discussions. Three strategies—stimulated recall, thinking aloud, and process tracing—provided the means for the teachers to give me information during the interviews and discussions.

I recorded each day's classroom and school observations in a field notebook. Several times throughout the day, I read the reconstructions of the interviews back to the teachers so they could add to and clarify what they had said. During the research, the teachers developed the habit of thinking aloud as they went about their teaching as a way for me to tap into their thoughts about teaching and technology. Several cross-checks were used in the study. Because these teachers had received national awards, I was able to read comprehensive accounts of their activities in journals and newspapers. Interviews with administrators, colleagues, friends, and family members also served to expand my understanding of these teachers.

Method of analysis

To analyze the information, I used a process Patton (1980, 1987) has outlined for organizing, analyzing, and interpreting information. After I wrote narratives based on the interviews and observations for each participant, I read the narratives several times. Using Agar's (1985) concept of *breakdowns*, I looked for discrepancies between my understanding of an event and theirs. These breakdowns alerted me to significant points to pursue in the analysis. I also used this technique during my initial review of the information during the visits. Rereading the completed narratives several times allowed me to organize the descriptive information into categories that emerged from these narratives. Once the categories had been established, I searched for patterns and themes, and used these patterns in the interpretation. I constructed this interpretation by finding linkages and relationships among the patterns which emerged from the analysis. I used this process for the information I had collected from each participant, and then compared the narratives of all five participants. The participants reviewed and discussed my interpretation of the descriptive narratives, by phone and at group and individual meetings.

Assumptions of the study

Much of what teachers do to prepare for instruction cannot be observed directly, and therefore must be inferred from what they do in the classroom, and what they say about their thoughts. In the end, we must rely on teachers to say what they are thinking (Spradley, 1979). Rather than viewing information gained from teachers themselves as suspect, I believe that they can provide the most pertinent information, because they are closest to the situation under study. Researchers, however, must provide teachers with time to do this, and opportunities to reflect on what they have said and written during the research process, and to add to the growing account. Through repeated cycles of talk and reflection, teachers are able to go beyond superficial descriptions and ideas to deeper understandings. By involving teachers in the research process in genuine ways, they not only have more opportunities to provide information, but they also become invested in the research.

REVIEW OF THE LITERATURE

The literature in two areas is relevant to this study: teachers' use of computers and teachers as designers. A study conducted by the Educational Technology Center (ETC, 1988b) investigated factors that influence teachers' decisions to use computers, and the influences of computer use on how teachers taught. Three factors were identified: teachers' knowledge of appropriates uses of computers; teachers' access to resources and support; and external forces that encourage or discourage use. The researchers found that specific reasons related to teachers' knowledge motivate teachers to use computers: a belief in the need to prepare students for the future, the computer's educational potential, and their own interest in computers. Teachers perceived their use of computers as affecting their teaching style and classroom organization (ETC, 1988a; 1988b). Teachers reported that inservice training often didn't prepare them to integrate computers into the curriculum and they needed additional support materials to achieve integration.

In another study from ETC (1988c) on using computers in guided inquiry, several factors were found to be important when teachers integrate computers into an existing curriculum. These were: congruence (fit with existing curricular goals), instrumentality (completeness of the new technology package), fit with existing practices, and fit with teachers' views of teaching and learning. The OTA report (1988) also noted that teachers who use technology first use it in ways that correspond with their customary, and often traditional, methods of teaching. Canning's study (1989) of educational innovators reveals similar patterns. Fit with existing needs, values, and practices was an overall theme in the reasons they gave for using computers. Using teacher decision making as a theoretical perspective, Winkler et al. (1984) assumed that teachers' use of computers fits into teachers' existing planning processes. With this perspective, they identified specific places within the decision making process into which computer use could be integrated. These researchers recommend that, to help teachers use computers, methods for integrating computer use into the planning process were needed. Shavelson et al. (1984) identified four types

of computer use: orchestration (multiple use with high integration into course), enrichment (computer literacy), adjunct instruction (subject matter mastery at conceptual level), and drill and practice (mastery of procedures related to content). Few teacher characteristics were related to the way teachers used computers. Foliart and Lemlech (1989) conducted a study based on Shavelson's design and found that aspects of the curriculum such as teachers' goals, subject matter, teaching strategies, grouping, and time spent at the computer were related to patterns of computer use.

Cuban's (1986) study of teachers' use of media describes the practical pedagogy of the teacher, one in which the teacher balances the costs of learning to use a new device or strategy with the predicted return on the investment for the student from the new tool or technique. This tendency is supported by the techniques already present in teachers' repertoires, knowledge derived from teaching experience, and policy. Because of constraints in the school environment, teachers make situationally constrained choices about the efficiency of new tools—what Doyle and Ponder (In Cuban, 1986) refer to as the practicality ethic. Cuban provides several reasons for the uneven and limited penetration of technology into teachers' instructional repertoires: poor access to technology, flawed implementation, little knowledge from their own teacher education, and classroom demands.

Becker's (1987) review of surveys, research reviews, and experimental studies concludes that work in this area so far offers little help to teachers about how to use computers. The results of the survey measuring teachers' perceptions and beliefs about the effects of computers on students showed that the majority of teachers reported that their teaching styles had not changed significantly with their use of computers.

Teachers as designers

Seeing the teacher as a designer is a more recent development in the history of research on teacher thinking and planning. Earlier research (Borko et al. in Peterson & Walberg, 1979; Shavelson, 1983; Joyce et al., 1981) characterized teachers as skilled clinicians who develop repertoires of instructional techniques and strategies which are stored for later retrieval and use. The means-end approach of this instrumental model was seen as inadequate and unsatisfying to many researchers who wanted a more true-to-life characterization of teachers' work based on teachers' thoughts and actions in their own terms (Calderhead, 1987; Feiman-Nemser and Flodin in Wittrock, 1986). These and other researchers see teachers as a source that can be tapped for practical knowledge, and encourage researchers to study the structure of this knowledge (Berliner in Calderhead, 1987). Calderhead (1987) also noted the need to understand how teachers develop and use their own knowledge.

Concepts such as problem space, problem framing, and reflection-in-action are now used to describe planning as a dynamic design process, rather than a matching of tasks to corresponding strategies (Connelly and Clandinin, 1988; Schön, 1983). Jackson (1986) encourages a constructivist view of teachers as transforming individuals, as artists and creators. Clark and Yinger (In Calderhead, 1987) also note that the teacher remains open during the class period to events that occur which were not part of the original idea. The teacher not only responds to these events, but bases subsequent action on the ongoing dialog with the situation. Clark and Yinger (In Calderhead, 1987) noted that teachers begin with a general idea which is progressively elaborated in the three-stage, design cycle of problem finding, problem formulation and solution, and implementation. They refer to a cyclical design process which allows teachers to adapt to situations rather than to apply rules systematically.

Schön's work on the nature of the activity of practitioners has influenced how teaching is seen (Calderhead, 1987) and the knowledge that they create about and within their spheres of practice. Clark and Peterson's review (In Wittrock, 1986) demonstrates the predominance of the clinician view in past research, and the shift to the teacher-as-designer view evident in more recent research. Simon's (1981) idea that all practitioners are designers points in a useful direction in the search for such a model. Simon detects a commonality among designers in all professions: that of creating artifacts—physical and mental—to reach goals. Donald Schön has developed Simon's notion of the nature of the design process in relation to how professionals operate in their particular domains. His

work on planning by professionals has also added to the current understanding of teacher thinking and decision making (Grimmett and Erickson, 1988). In Schön's model, professionals work in complex, unique, and indeterminate environments, and must continually deal with uncertain events. Practitioners create and use knowledge by identifying the salient features of a situation, framing a question, building and testing interpretations, reflecting, and then reframing the question in view of their current understanding (Schön, 1987). They repeat this process of experimentation until they have constructed an understanding of the situation.

In recent work, Schön (1990) has extended his model for generating professional knowledge. His conception of a "design world" provides a framework for the previous work, and focuses on how practitioners create the environments in which they operate. He views the design process as a reflective conversation with the materials of an uncertain and complex situation. He proposes that in these situations, practitioners face two problems: the design of the work at hand, and the design of their own system of design, or design world. Practitioners bring prestructures to the design process: preformed attitudes and ideas, knowledge and skills, all of which affect an individual's ways of seeing and strategies for selecting materials from the technical universe. Through experimentation with the materials in the technical universe, a person begins to understand the situation, and to select materials for use based in part on likes or dislikes developed during experimentation.

RESULTS

The analysis revealed that the teachers previously had established a process for developing ideas for lessons, units, and courses, and for their curricula as a whole. The process itself was largely tacit; the teachers rarely had thought about the process which they described. Their processes incorporated highly individualized systems of meanings that had evolved throughout their careers as teachers. Although each process was configured uniquely, they had several distinguishable features in common—elements, framework, guiding principles, and phases. Each of the processes consisted of a limited number of elements which were combined into a unique framework or structure. The process itself had several identifiable phases or stages: gathering, inquiring, putting together, and using.. A set of beliefs—guiding principles—about teaching, learning, and students directed the process. These beliefs act as guidelines for the design process and its eventual outcomes, and are a product of the teachers' reflection on their teaching experiences. Categories of guiding principles include: the teachers' goals for teaching in general, their goals for classroom events, beliefs about how students learn, beliefs about how teachers should teach, goals for what they want their students to experience in their classrooms, and subject specific goals. These guiding principles range from fundamental, overarching beliefs to specific beliefs about instruction in their content areas.

The process by which the teachers developed ideas for classroom activities using technology had neither new elements nor special frameworks, and the phases occurred as they did in the general process of design. Their thinking about the use of technology occurred within the larger process of design they had established. The teachers have further defined their guiding principles by using various forms of technology and then creating a subset of guiding principles about the technology, in this case, computers. As a whole, the guiding principles about technology are extensions of the overall guiding principles these teachers hold. The subset pertaining to technology contains categories of beliefs about computers: the effect of computers on them as persons and teachers, the effect of computers on students, the nature of computers, and uses of technology in specific subjects and grade levels.

Ruth, for example, believes technology can help her to reach more students: "I can't provide for all needs. For example, some kids need quiet. I have guilt at not meeting all their needs. Maybe different delivery systems help reach different learners."

Ed sees the computer as "just another machine," that like any machine, is another way to teach technology education. He feels that his students need to know about computers; it is "consumer knowledge" for the students. His goal in technology education is "computer exposure."

George sees a future society in which technology will be used in all aspects of life. Therefore, he feels he can best serve his students by making them better prepared to live in a technological

society. "All the things I teach are related to a global, far-reaching dimension." He wants them to leave his classes with the skill to solve problems by applying technological tools.

Caroline's guiding principles echo the other's. To her, the significant aspect of the computer is that it provides another "delivery system" for information. "Books or computers, they're just other ways to find information," she says. As with the others, technology is, "Just a tool, a way to extend the curriculum." She doesn't want to see "a break between the book and computer, but a nice blending." She also believes they can help her to reach different learners: "Technology helps to reach kids, maybe it makes it easier for them to learn. It helps them develop skills in group work and in decision making."

Themes in design

Several patterns or themes emerged in the analysis of their design processes. Although they are interwoven among one another, these themes (and subthemes) can be listed separately: the ideal (grounded in the real), the contingent (flexibility and responsiveness), exploration (going beyond the classroom, creating a rich environment, and preparing themselves as teachers), and outreach (looking for new ideas and reshaping ideas). The themes that emerged in the teachers' reflections about their design processes reappeared in their discussions of their use of technology.

The ideal. Each of the teachers carried an image of what their lesson, unit, or curriculum *could* be. Referring to some curricular materials she saw, Ruth says, "It looked good. I liked it the minute I saw it. It matched the image of what I was using." The image is of what *could* be is with them such that they can measure what they are currently able to do against this image. Yet this image does not cloud their perception of the real world in which the operate. They are grounded in the conditions of the real world as reflected in the demands and constraints of their classrooms, school districts, and communities.

Using technology has allowed them to approach more closely the vision, the image, that they have always had of an activity. George explains: "All the things I teach now are related to a global far-reaching dimension. It hasn't changed my process or style. ... The dimensions have changed." With technology, they are more able to realize their ideal. Moreover, they see work that they have done in the past as being extended by technology. Therefore, they don't plan *for* computer use so much as they create activities in which the use of computers will make the activity occur as they want it to occur.

The contingent. They have an appreciation of the value of the contingent in the classroom, and in their own experimentation. They expect the unexpected, they relish the unpredictable, and look forward to the accidental. They look for the challenge in the unforeseen. George, therefore, can look at his plans as "a guide, not a jail." These teachers approach their classrooms with an attitude of flexibility. After a lesson in which the equipment broke, Ed said: "You must be flexible. Now what if my lesson plan said I *had* to do this? Where would I be then?" A subtheme related to flexibility is responsiveness to students' needs. Although the teachers have gained through experience a strong sense of what students need, they are open to what the students themselves tell them they need. Because they can be flexible in what they do in their classrooms, they can incorporate what interests their students.

With respect to the contingent, the teachers found that when they use computers and other technology in classroom activities, unexpected results often occur. Sometimes, for example, a student will show them a feature of a program that the teachers did not know about. Rather than being uneasy at the prospect of not having "known it all," the teacher is pleased with the student's discovery. George shares his own discoveries with students: "Look at what I just learned to do last night." When asked about how a piece of equipment works, Ed responds, "I don't know; let me research it and get back to you." They also see students' questions and discoveries as critical points in a lesson, points at which they can information, even though they had not planned to do so.

Exploration. When these teachers find something new, they "play" with the idea or object. Through this experimentation, they discover what they can do with the object, or how they can use they idea. They look forward to this activity, and encourage their students to experiment also. They are not threatened when students show them what they have discovered; they are delighted.

These teachers are continually looking for new ideas and materials. When they find some idea or object that is interesting to them, however, they rarely adopt it as is. More often, they reshape the materials they find or the ideas they discover in their experimentation; they adapt them to reflect their own images.

Their orientation to look for the new—the theme of exploration—led them to first use computers, as it has led them in the past to other materials. They have a hands-on approach to exploration and while working with new objects, they develop inclinations to favor certain things over others. When she got her first computer, Ruth would return to school at night and to use the equipment When she gets a new piece of equipment or software, Ruth uses it herself and then says to her students. "This is what I know, this is what I don't know."

Outreach. Each expressed a desire to be able to "go beyond the classroom walls." This phrase appeared many times for each participant, in nearly identical forms among all four participants. The teachers try to take their students to places away from the school. If it is not possible to go out into the world, the teachers bring the world to the students, into the classroom. They attempt to create a rich environment for the students by bringing things to the classroom. Their classrooms overflow with "stuff," as the teachers call it. They see themselves as a part of the classroom environment, as additional resources for the students. Thus, they try to "soak up" information about anything with which they come into contact so that they can use this at the appropriate time with their students.

The teachers brought computers into their classrooms in an effort to add to the stockpile of ideas and materials so that many possibilities–foreseen and unforeseen—could be pursued. The computer is not only a part of this environment, but it also creates its own environment. It is at the same time, therefore, part of an overall environment, and the center of another environment. The teachers, however, extend the same effort to bringing computers as they do to bringing other materials; they continue to look for, experiment and learn about ideas and things not related to computers. Each day they brought their own computers to school, but they also carried bags of other materials: books, clay, maps, newspapers, and whatever else they found that they thought would be useful to them or their students. Through this activity, they prepare for further exploration and creation by having materials and equipment which are waiting to be used.

An additional theme, however, extends over and links the other themes. This theme is captured by the phrase "it's [the computer] just a tool," a phrase that the teachers used repeatedly to describe their orientation to the computer, as teachers. Their answers to the question of what this phrase means to them indicated that they believed the computer fit into their existing approach to teaching, which they referred to as their teaching style or philosophy. Computers enabled them to fulfill their educational goals, goals which the themes highlight. With computers they could: do what they always wanted to do (the ideal); do what might come up, or become possible, or interesting (the contingent); explore (inquiry); and reach beyond the limits of the classroom (outreach). Learning about computers also fit into the process they used to learn about other materials or ideas for the classroom. It also fit their individual guiding principles, such as their predisposition to look for new ideas and objects to incorporate into their curricula.

They see computers as one of many tools, as one object among a variety of others that can be used in the classroom. Creating a classroom environment that supports conversation with the situation—design or reflection-in-action—is accomplished through this belief in the computer as a tool. This belief provides an internal framework for their use of computers, and by acting on this belief they create the external conditions in the environment that encourage and allow more use of the computer to occur.

INTERPRETATION

In the process of finding solutions to instructional problems, the teachers in this study built personal design worlds consisting of materials, ideas, processes, approaches, tools, and thoughts; it is through these design worlds that they continue to solve new problems. These systems result from past problem solving experiences, but are also open to the influence of new ideas and materials. They had constructed a design world from the pieces at hand, using their assumptions, likes, and dislikes of both materials and strategies. They made choices based on their ways of

seeing the materials in the technical universe. These ways of seeing are linked to their likes and dislikes of the various objects and ideas that they test in their process of exploration and discovery. In this process, they make judgments about the usefulness of ideas and things, and come to understand the limits of objects and ideas. With each succeeding venture into their design worlds to solve a particular program, the create additional opportunities to expand this design world. In this way, they continue to add to their design worlds. Rather than accepting the limits of their classrooms with respect to resources, they consciously build an expanding technical universe, one in which their daily explorations occur. Their crowded classrooms reflect this, as does their habit of carrying bags of objects, including computers and software, between home and school. Likewise, they treat the computer as a portable resource for their classroom, carrying them to school many days. They keep the necessary materials at hand so they will be able to capitalize on opportunities. They don't want to lose opportunities simply because they did not have the "stuff" available, including the computer.

Each of the teachers had access to similar materials, processes, and tools—the technological universe—but because each of them perceived these tools and materials differently, they chose different items and therefore, each created a unique design world. Their interpretations of the task—how computers should and could be used—were also different, and were shaped by their views of the materials, tools, and processes each had selected to use. So although each teacher used computers in their design world, each teacher had a different reason for doing so. Through their interpretations of the task at hand, they set the boundaries of the problem of how to use computers; they frame the problem according to the important ideas contained in their guiding principles. In the process of discovery, they have found qualities of objects or ideas that they like or do not like. The teachers' preferences—their likes and dislikes as Schön refers to them—have an important place in their networks of prestructures. These preferences are not arbitrary, but rather, are based on their experiences in the classroom, both as a teacher and as a student. Concern about students, not technology, is an important element in this.

They also bring assumptions to the task including their guiding principles about teaching and learning in general, and particularly those pertaining to the use of technology that they have already developed. They begin their exploration of computers with these preexisting, general guiding principles. During their exploration of computers, they develop specific guiding principles relating to technology. These new prestructures are a result of continuous exploration and are constantly updated. There is substantial agreement between the general and specific sets of guiding principles. For example, Caroline wants to provide variety for her students. Thus, she has added computers to her design world, because they provide that variety for her students. The technology subset enables the goals of the larger set of guiding principles to be fulfilled. The secondary set is not fully formed after the initial discovery of the computer or any other device; these beliefs are refined after repeated trials in the classroom.

CONCLUSIONS

There are several conclusions that can be drawn from this study: teachers use a common process to create lessons, including those lessons in which technology is used; this process has several features including overall goals in the form of guiding principles; this process resembles the process of design; and teachers' use of technology occurs within their general process of design, within their own design world. The process is not different from the process they used to design non-technology lessons, the process they used before they used computers and related technology. They were able to apply the process that they had developed to design other lessons to the design of lessons which included the use of computers. They use it because it works; it leads them from an idea to a lesson. The process has also allowed them to make sense of the computer—what it is and how to use it—within their own design worlds. What is discovered in this process is added to the growing body of guiding principles. The whole range of guiding principles is applied when designing technology lessons, not only those about technology. Their design worlds—the tools and materials that are seen, how they are seen, and how they are used—were created through experiences with ideas and objects, and on assumptions they made about these ideas and objects.

Carlson, E. U. (1991, April). *Teaching with technology: "It's just a tool."* Paper presented at the annual meeting of the American Educational Research Association, Chicago.

The teachers in this study viewed computers as a potential tool to be used in all subject areas and grade levels. In this sense, it was "just another machine" for providing or delivering information, preparing students for the future, or as a way to extend the curriculum. Moreover, they saw it as allowing them to think and do simultaneously. They saw its effect on them as teachers as changing the dimensions of teaching from local, bounded by classroom walls, to global, with no boundaries. They believed that computers also made it possible for them to reach more, and different kinds of, learners and enabled them to meet the needs of more students, and to prepare their students. They saw their challenge as determining how to put the computer to work in their subject and grade level. They felt that they were beginning to think with a computer, as in the past they had thought with a pencil or typewriter. The computer also eased certain tasks, like grading, or writing. With respect to the computer's effects on students, they believed it motivated and interested students by providing independence, fun, or variety, and made certain tasks easier for students to accomplish. It also allowed students to beyond the walls of the classroom, and prepared them for their futures. They had specific ideas of how computers could, or should, be used, with students in classrooms. They used it most often with other objects, and in a variety of modes—individual, group, demonstration. They believed that students should be able to experience many different types of uses, and not be limited to only one type of use such as drill and practice. They saw the computer as another tool to use to teach and learn a particular subject or topic, to do a job, perhaps more quickly or more thoroughly than without computers.

Their use of the computer is not at the center of the image that prompts a particular lesson. In fact, the use of computers in lessons doesn't necessarily begin with computers. Each of them has made the personal discovery that computers can help them as teachers. Therefore, their use of them is a genuine integration of an object into their teaching, not into the curriculum. Rather than asking how they could integrate the computer into the curriculum, they have found ways to integrate it into what they do as teachers; in this way, it has become their teaching tool. Which is not to say they don't make deliberate and concerted efforts to encourage their students to use them. When they do so, however, it is to help their students see the computer as a tool, in the way that they themselves see it. They don't use computers in isolation from other materials but along with other things. Computers don't take precedence over other objects. Because it is their tool, they make choices to use it or not to use it based on the same criteria they use for other instructional materials and methods. Their choices are influenced by the guiding principles and their likes and dislikes. The use of technology enables them to realize long-standing educational goals as reflected in the themes. To the degree that the use of technology enables the guiding principles to be realized, it will be used; but their personal likes and dislikes will mediate the process of deciding how and when to use the technology.

Using Schön's model, we have seen not only the existence of, but also the operation of the design worlds in which teachers make new sense of materials and then make new uses of it. They restructure and rework the situation to open up new paths. The methods by which teachers allow new materials in the technical universe to enter their design worlds are of particular importance for teacher educators, who want to know why some teachers use computers and others do not. Even though they have access to more or less the same materials, all teachers do not use the same materials. Preferences appear to be important considerations and this might be especially important as teachers begin to use new media, methods, and materials. The teachers' excitement about the use of technology was not about the technology itself, but rather, about being able to realize their educational goals.

Implications

With respect to practice, this study has implications for how teachers view themselves, and how they are viewed by others including teacher educators and researchers. The results of this study support the idea that, as professionals, teachers engage in common activities about which they can talk. One of these activities is the design of curricula and lessons. The participants in the study believed that they did not have the words to talk to others about how they created lessons; in fact, they said that they rarely talked to anyone about creating lessons. Although they realized that

they lacked words to talk about design, or to think about it, once they had found the words, they found their thoughts and discussions about the process to be both useful and satisfying.

Because this study looked at teachers with at least ten years of experience, the results are most logically and easily applied to inservice education. The findings from this study can be applied to teacher education, both general education and the specific education for the use of technology, from the perspective of the teacher as a learner, and the teacher as an instructor of peers. The teacher who is learning about using computers might be more likely to integrate this technology into what he or she is doing in class, if this new knowledge can be placed within an existing framework, one with which the teacher is already familiar. Inservice instructors then, must be able not only to describe the process of design, but also to help their colleagues discover their unique manifestations of this process. Because designing for the use of technology occurs within the same process as the design of other lessons, inservice instructors must demonstrate how teachers can find and talk about their individual processes. As they plan inservice workshops in which teaching is presented as a design process, they will need to identify the attitudes, conditions, and materials that teachers need to design.

Recognizing that design worlds are personal creations, teacher educators will not attempt to impose a standard model of design on teachers. Rather, they will help teacher develop unique design worlds that will allow teachers to incorporate the use of technology into what they already do, into what teachers often call their teaching style or teaching philosophy. Inservice that takes into account different design worlds acknowledges that teachers have reasons for their actions. If, for example, a teacher's design world appears to be closed—new selections are not being made from the growing technical universe—the question then is how to encourage the teacher to try to use new things, as they once did. If school administrators, technology coordinators, and others who confront the effects of teacher likes and dislikes are aware of the process of design, they might then address them as valid and real. Knowing the effects of guiding principles and other prestructures, educators will not discount them, but find ways to help the teacher understand that part of teaching is the ability to create new solutions, and that this is particularly so with computers and other technology. Inservice needs to give teachers the ability and confidence to invent solutions, often on the spot. The results of this study underline the importance of linking what teachers do with computers to what they already do. This study gives some indication where this linkage can be made, and where it has to occur.

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